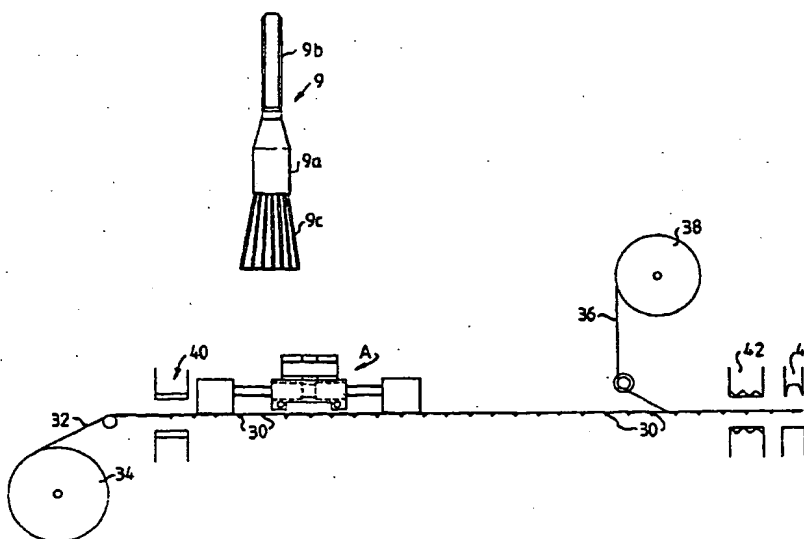




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

|   |  |  |  |
|---|--|--|--|
| (51) International Patent Classification <sup>6</sup> :<br><b>B65B 9/04, G01F 13/00, A61J 3/07</b>  |  | A1   | (11) International Publication Number:<br><b>WO 95/21768</b>   |
|   |  |  | (43) International Publication Date: 17 August 1995 (17.08.95) |
| (21) International Application Number: PCT/SE95/00109   |  | (81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SI, SK, TJ, TT, UA, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ). |  |
| (22) International Filing Date: 6 February 1995 (06.02.95)  |  |  |  |
| (30) Priority Data:<br>9400462-9 11 February 1994 (11.02.94) SE   |  |  |  |
| (71) Applicant (for all designated States except US): ASTRA AKTIEBOLAG [SE/SE]; S-151 85 Södertälje (SE).   |  | <p><b>Published</b></p> <p><i>With international search report.</i></p> <p><i>Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.</i></p>   |  |
| (72) Inventors; and   |  |  |  |
| (75) Inventors/Applicants (for US only): HANSSON, Ulf, Henri [SE/SE]; PI 259, S-244 95 Dösjebro (SE). PETERSSON, Jan [SE/SE]; Kämpagränd 19 A, S-224 76 Lund (SE). CLAUSNITZER, Peter [DE/DE]; Blechbergele 11, D-715 22 Backnang (DE). |  |  |  |
| (74) Agent: ASTRA AKTIEBOLAG; Patent Dept., S-151 85 Södertälje (SE).   |  |  |  |

(54) Title: PROCESS AND APPARATUS FOR FILLING COHESIVE POWDERS



## (57) Abstract

The invention relates to a device for filling with high accuracy a finely divided powdered medicament having a particle size smaller than 10  $\mu\text{m}$  into cavities having a size corresponding to the volume of powder to be filled, wherein said device comprises oscillating and rotating means for breaking down aggregates formed in the finely divided powdered medicament and filling and for compacting it in said cavities. The invention also includes a method of filling with high accuracy of a finely divided powdered medicament having a particle size smaller than 10  $\mu\text{m}$  and to fill said finely divided powdered medicament into cavities, wherein the finely divided powdered medicament is transported and compacted in said cavities by oscillating and rotating means.

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

|    |                          |    |                                       |    |                          |
|----|--------------------------|----|---------------------------------------|----|--------------------------|
| AT | Austria                  | GB | United Kingdom                        | MR | Mauritania               |
| AU | Australia                | GE | Georgia                               | MW | Malawi                   |
| BB | Barbados                 | GN | Guinea                                | NE | Niger                    |
| BE | Belgium                  | GR | Greece                                | NL | Netherlands              |
| BF | Burkina Faso             | HU | Hungary                               | NO | Norway                   |
| BG | Bulgaria                 | IE | Ireland                               | NZ | New Zealand              |
| BJ | Benin                    | IT | Italy                                 | PL | Poland                   |
| BR | Brazil                   | JP | Japan                                 | PT | Portugal                 |
| BY | Belarus                  | KE | Kenya                                 | RO | Romania                  |
| CA | Canada                   | KG | Kyrgyzstan                            | RU | Russian Federation       |
| CF | Central African Republic | KP | Democratic People's Republic of Korea | SD | Sudan                    |
| CG | Congo                    | KR | Republic of Korea                     | SE | Sweden                   |
| CH | Switzerland              | KZ | Kazakhstan                            | SI | Slovenia                 |
| CI | Côte d'Ivoire            | LI | Liechtenstein                         | SK | Slovakia                 |
| CM | Cameroon                 | LK | Sri Lanka                             | SN | Senegal                  |
| CN | China                    | LU | Luxembourg                            | TD | Chad                     |
| CS | Czechoslovakia           | LV | Latvia                                | TG | Togo                     |
| CZ | Czech Republic           | MC | Monaco                                | TJ | Tajikistan               |
| DE | Germany                  | MD | Republic of Moldova                   | TT | Trinidad and Tobago      |
| DK | Denmark                  | MG | Madagascar                            | UA | Ukraine                  |
| ES | Spain                    | ML | Mali                                  | US | United States of America |
| FI | Finland                  | MN | Mongolia                              | UZ | Uzbekistan               |
| FR | France                   |    |                                       | VN | Viet Nam                 |
| GA | Gabon                    |    |                                       |    |                          |

## PROCESS AND APPARATUS FOR FILLING COHESIVE POWDERS

### Technical field of the invention

- 5 The invention relates to device for filling, with high accuracy, finely divided powdered medicament having a particle size smaller than 10  $\mu\text{m}$ .

### Background of the invention

10

Powders consisting of very small particles are commonly used in the inhalation therapy where the size of the particles are of utmost importance. The diameter of particles which are to be inhaled must be less than 10  $\mu\text{m}$ , preferably between 6 to 1  $\mu\text{m}$ , to ensure adequate penetration of the particles  
15 into the bronchial area of the lungs.

Most finely divided powdered medicaments, such as micronized powders, are light, dusty and fluffy and they often create problems during handling, processing and storing. For particles having a diameter less than 10  $\mu\text{m}$  the  
20 van der Waals forces are generally greater than the force of gravity and consequently the material is cohesive and tends to form irregular agglomerates. Powders having such particle sizes are also very sensitive to electrostatic charges which readily arise in such powders during handling. These powders have very poor free-flowing properties and during handling  
25 bridges between the particles will be formed leading to the build up of the aggregates.

When finely divided powders are to be filled into reservoirs, compartments, cavities or depressions of different kind and sizes, such as cavities provided on an elongate carrier, for example a layer of foil, a piece of moulded plastic or similar, the aggregates must be broken down in order to make possible  
5 the filling of the powder into the cavities. One way of avoiding the build up of aggregates and to break down those that have been formed is to subject the finely divided powder to movement, e.g. agitation. This could be done by using mechanical devices, such as stirring means, or by using electronical means such as means creating ultra sound or similar.

10

This break-down of aggregates is especially important when small amounts, e.g. between 10 mg to 0.1 mg, in particular 5 mg to 0.5 mg, of finely divided powdered medicaments are to be filled into cavities formed to receive the required exact amount of the powder.

15

Another important factor when filling medicaments is the degree of compaction. This is especially important when filling finely divided medicaments into cavities which, in particular, are to be used for inhalation with breath-actuated, dry-powder inhalators, as the medicament must be  
20 lifted out of the cavities by the force created by the airstream produced by the patient during inhalation.

The powder present in the cavities must also be able to break down into the particles having a particle size smaller than 10  $\mu\text{m}$  during inhalation in order  
25 to provide a dose comprising high proportion of particles within the respiratory range of less than 10  $\mu\text{m}$ . The compaction may therefore not be too strong. On the other hand, in order to avoid the possibility that the medicament falls out of the cavity when it is positioned for inhalation but before it has been inhaled, the medicament must be compacted to a certain

degree so that it is retained in the cavity until inhalation. A controlled compaction is therefore of utmost importance.

## 5 Prior Art

It is known in the prior art to provide different types of apparatus for filling medicaments into capsules. In CH-B-591 856 is a device for forming and filling capsules with fluid medicament described.

10

US-A-2 807 289 describes a device for filling small bottles with antibiotics. According to this document a powdered medicament is fed to an outlet by using a screw device where each turn on the screw meters a certain amount of powder. Such an apparatus cannot be used in modern inhalation

15 technology as the amount of powder which is to be filled into cavities is very small compared with the amount of antibiotic filled into bottles. It is not possible to fill very small amounts sufficiently in an accurate manner with the apparatus described in this document.

20 A method of filling very small amounts of finely divided powders is described in EP-A-0 237 507. According to this document aggregates of finely divided powdered medicament are fed to cavities provided on a dosing unit, e.g. a perforated membrane or disc. The exact dose is filled by breaking down the aggregates by using scrapers activated by a manual

25 turning of the dosing unit. This method is used in the breath-actuated, dry powder inhaler called Turbuhaler®. However, a method according to this document is not possible to modify to provide a method of continuously filling cavities provided on an elongate carrier or similar in accordance with the present invention. It is especially difficult to modify the method to be

used industrially. It is also commonly known in the prior art to use different types of apparatus for filling resevoirs in copying machines and for feeding powder in such machines. However, in this case the accuracy of the fed doses is of less importance compared with the demands of accuracy when  
5 filling exact doses of pharmaceuticals, in particular when filling highly potent pharmaceuticals to be used, for example, in inhalation therapy. As none of the known devices are dealing with the present problem of filling and compacting finely divided powdered medicaments for the inhalation therapy a solution to the stated problem is not found in the prior art.

10

#### The invention

The present invention relates to advice for filling with high accuracy a finely  
15 divided powdered medicament having a particle size smaller than 10  $\mu\text{m}$  into cavities, preferably provided on an elongate carrier or similar, such as cavities formed on an aluminium or plastic layer or tape.

In the following description the wording "small amount" relates to amounts  
20 having a weight between 10 to 0.1 mg, in particular between 5 and 0.5 mg.

The invention provides a device for filling with high accuracy a finely divided powdered medicament having a particle size smaller than 10  $\mu\text{m}$  into cavities having a size corresponding to the amount of powder to be  
25 filled, wherein said device comprises oscillating and rotating means breaking down aggregates formed in the finely divided powdered medicament and for filling and compacting it in said cavities, as described in claim 1.

The invention further provides a method of filling with high accuracy a finely divided powdered medicament, having a particle size smaller than 10  $\mu\text{m}$  into cavities having a size corresponding to the amount of powder to be filled, wherein the finely divided powdered medicament is transported to  
5 and compacted in said cavities by oscillating and rotating means, as described in claim 10.

Further preferred embodiments of the method and the device according to the invention are clear from the dependent claims 2 to 9 and claims 11 to 13,  
10 respectively.

The present invention further provides a method and an apparatus for manufacturing an elongate member with cavities containing finely divided powdered medicament as described in claims 14 to 15 and 16 to 17,  
15 respectively.

There is also provided the use of the method and device according to the invention for filling a finely divided powdered medicament into cavities of a single unit dose, breath-actuated, dry powder inhalator, said cavities being  
20 present on an elongate carrier, as well as for filling such medicaments into cavities of an elongate carrier to be provided in a multi-dose, breath-actuated, dry powder inhalator for multiple use as described in claims 18 to 20.

25 The cavities could preferably be provided, e.g. pre-formed, on an elongate carrier and have a size which is determined by the amount of powder to be filled into the cavities.

The greatest amount of finely divided powdered medicament which can be  
30 filled into the cavities using the filling device according to the invention in

the embodiments described in the description is 10 mg and the smallest amount is 0.1 mg, but by modifying the filling head within the scope of the appended claims other amounts could also be filled. In the preferred embodiments the cavities could have a volume between 0.5 and 25 mm<sup>3</sup> corresponding for many medicaments to a dose of 0.1 and 10 mg, respectively. In the preferred embodiment of the present invention the cavities have a volume between 0.5 to 12 mm<sup>3</sup> corresponding to a dose of 0.1 to 5 mg, most preferably between 2 to 12 mm<sup>3</sup> corresponding to a dose of 0.5 to 5 mg.

10

The construction of the filling head according to the invention provides a solution to the problem of filling exact quantities of a finely divided powder into cavities in an continuous manner to be used industrially. The device and method also makes it possible to solve the problem of filling cavities of an elongate member whereby the waste of material is minimized.

15

#### Brief description of the drawings

20 Fig. 1 shows a preferred embodiment of the device according to the invention in a side view,

Fig. 2 shows the device in fig. 1 in a top view,

25 Fig. 3 shows the device in fig. 1 in a front view,

Fig. 4a shows a first embodiment of the stirring device 9 in fig. 1,

Fig. 4b shows a second embodiment of the stirring device 9' in fig. 1,



Fig. 5 shows the device according to the invention mounted in a preferred embodiment of an apparatus for continuous production and filling of a strip of material of an elongate carrier provided with cavities,

5 Fig. 6 shows a further preferred embodiment of the apparatus in fig. 5, and

Fig. 7 shows a view from above of the elongate carrier with the cavities during the different operations of the apparatus in fig. 6.

10

Detailed description of the drawings

A preferred embodiment of the device according to the invention is shown in figs. 1 and 2. The device is intended to be used for filling with high  
15 accuracy finely divided powder, in particular pharmaceuticals, into cavities provided on an elongate member 3. Said elongate member 3 contains a plurality of the cavities 30 arranged in a row.

The device comprises a supporting frame 17 and a filling head 14. The  
20 supporting frame consists of a beam construction and is at one end mounted on a stand including a motor 22 and a gear box 23. The other end of the supporting frame 17 provides a support for the filling head 14 and a stirring element 9 arranged in the filling head.

25 The filling head 14 consists of a substantially I- formed element and is provided with a powder compartment 15 acting as a powder supply during the filling action. Said powder compartment 15 is in the form of a substantially circular groove provided excentrically in and close to one edge of the filling head 14.

substantially circular groove provided excentrically in and close to one edge of the filling head 14.

The filling head 14 is mounted on two sets of guides 4, 6 mounted perpendicular to each other. The first set of guides 4 are provided parallel to the feeding direction of the elongate member 3 when this is arranged in the apparatus according to the invention, see figs 3 and 4. The second set of guides 6 are mounted perpendicular to the first set of guides 4 as can be seen in figs. 1 and 2. The filling head 14 is mounted on this second set of guides 6. During the filling action the filling head is placed directly above the cavity which is to be filled in the row of cavities arranged on the elongate member 3. The guides 4 are mounted with bearings 5 in a supporting beam 21. Said supporting beam 21 is arranged on a crane balks 1 provided with a bottom plate onto which the elongate member 3 is placed for the filling process. The supporting frame 17 are mounted on a mounting element 18, which is mounted on crane balks 1.

A shaft 13 is arranged excentrically in the filling head 14 adjacent the powder compartment 15. The shaft 13 is fixedly mounted in the filling head by bearings 19. Said shaft 13 extends upwardly from the filling head and is mounted in a linking arm 12.

A main shaft 10 is provided and arranged with one end adjacent the shaft 13 in the linking arm 12. The main shaft 10 extends upwardly through gear wheels 11 and is mounted in bearings 24 in the supporting frame 17. The other end of the main shaft 10 extends beyond the supporting frame 17 as can be seen in fig. 1. The main shaft 10 is connected to a motor 22 via a transmission belt 16 and a pair of driving wheels 20a, 20b. One of the driving wheels 20b is arranged with a pin 25b on the main shaft 10 and the other driving wheel 20a arranged with a pin 25a on a motor shaft 26 extending from the motor 22 and a gear box 23.

A stirring element 9, 9' is arranged in the powder compartment 15 of the filling head 14 and is rotated during the filling action. Said stirring element 9, 9' is in the preferred embodiment formed as an elongate element having substantially two parts 9a, 9a' and 9b, 9b'. The first part 9a, 9a' is formed as a transporting element which in a first preferred embodiment is substantially circular and formed as a brush 9a having bristles 9c, as can be seen in fig. 4a.

In a second embodiment the first part 9a' is formed as a substantially cylindrical, rigid element in which cut outs or grooves 9c' are provided, as shown in fig. 4b. The second part 9b, 9b' is formed as a shank for the first part and is mounted in a shaft 7.

The shaft 7 is mounted through bearings 27a, 27b in the supporting frame 17, as shown in fig. 1. A pair of gear wheels 8 are arranged around the shaft 7 and in acting contact with the gear wheels 11 of the main shaft 10. Said gear wheels 8, 11 are provided with lockings 21.

During operation of the filling device finely divided powder is supplied to the powder compartment of the filling head 14. This could be done in any suitable manner but in the preferred embodiment a screw feeder of a known type is used, but any other type of powder feeder could be used. As mentioned above aggregates and bridges will be formed in the powder in the powder compartment 15 and have to be broken down in order to make filling of the cavities possible.

In order to break down the aggregates formed in the powder compartment 15 the filling head 14 and the stirring element 9, 9' are moving. Due to the construction of the filling device the filling head 14 will describe an oscillating movement with regard to the cavity and the stirring element 9, 9'. The stirring element will rotate around its central axis within the oscillating

powder compartment 15. The movements are described in more detail below.

A force is applied via motor shaft 26 by the motor 22 to the driving wheel  
5 20a. The transmission belt 16 transfers the rotation of the driving wheel 20a to the driving wheel 20b and to the main shaft 10. The rotation of the main shaft 10 is transferred to the linking arm 12 and to the shaft 13 of the filling head 14. Due to the excentrical mounting of the shaft 13 in the filling head 14, the filling head will describe a oscillating movement in relation to the  
10 elongate element 3, the cavity 30 arranged under the filling head and the stirring element 9, 9'. The rotation of the main shaft 10 is also transferred to the shaft 7 of the stirring element 9, 9' via gear wheels 11 and 8. Rotation of the shaft 7 will provide the stirring element 9, 9' with a rotation around its central axis. The stirring element 9, 9' is thereby fixed in the horizontal  
15 directions and is only rotating around its central axis.

The motor 22 is in the preferred embodiment electrical but other kinds of motors, such as pneumatic or hydraulic, can be used.

20 The function of the stirring element 9, 9' will now be described. When the cohesive powder is filled into the powder compartment 15 and this is oscillating around the stirring element 9, 9' powder will be built up between the stirring element 9, 9' and the edges of the powder compartment 15. Due to the rotation and construction of the stirring element powder will be  
25 moved from the built up of powder into the center of the first part 9a, 9a' of the stirring element and forced down into the cavity 30. This rotational force will also provide a compaction of the powder in the cavity, as powders is continuously forced down into the cavity during the filling action. A controlled compaction is achieved by optimizing the amount of rotations of  
30 the stirring device.

The bristles 9c of the first embodiment of the stirring element 9 have been shown to be very efficient in transporting powder from the built up within the powder compartment 15 to the cavity and provides also sufficient force to give the powder the required compaction within the cavity. The cut outs 9c' provided in the rigid element 9a' of the second embodiment of the stirring element functions in the same manner as the bristles 9c and has also shown to be effective for the transportation of powder from the powder compartment to the cavity as well as providing a sufficient compaction of the powder in the cavity.

The amount of oscillating of the filling head 14 is dependant of the characteristics of the powder and on the amount of powder to be filled in each cavity. Tests have shown that in order to fill the required amount of powder into the cavities and to give the powder in the cavity the required degree of compaction the filling head shall rotate preferably 1 to 6 times, more preferably 3 times, over the cavity but this is related to the characteristics of the powder and may vary between different powders. The form and size of the crystals and the cohesivness of the finely divided powder, as well as the content of moisture and the ability to equalize the electro-static forces created in the powder are characteristics which determine how easily the powder can be compacted and thereby determining the number of times the filling head must rotate over the cavity to provide the required degree of compaction.

25

It has been shown that when filling finely divided powdered substances having a particle size smaller than 10  $\mu\text{m}$ , such as budesonide, lactose, terbutalinesulphate as well as mixtures of these substances, the amount of times which the filling head has to rotate over the cavity is about 3. With 1 rotation the compaction is too loose and the powder may fall out of the

30

cavity during handling; and 6 rotations do not add any substantial further compaction to the powder in the cavity when powders of the above mentioned type are filled.

- 5 It has also been found that other finely divided powdered medicaments having other crystal structures may require further degree of compaction leading to an increased number of times which the filling head needs to be rotated over the cavity.
- 10 In the preferred embodiment the filling head 14 comprising the powder compartment 15 as well as the stirring element are made of a material which gives rise to a minimum of electro-static charges so that a minimum amount of the finely divided powder accordingly adheres to these parts of the device. The material must also have a low friction relative to the material of
- 15 the elongate member 3 (cf fig. 3) in which the cavities are provided, as the edges of the powder compartment are moving in contact with the elongate member during operation of the device. Materials useful for this purpose are plastics, such as carbon-treated plastics, for example POM, metals, such as aluminium or stainless steel, or mixtures of plastics and metals, such as, for
- 20 example, aluminium covered with PTFE or carbon-filled POM. The fact that the edges of the powder compartment 15 of the filling head 14 is in contact with the edges of the cavity and the surrounding material is important for the filling of the cavity as this avoids leakage of powder between the filling head and the elongate member. Such leakage will give rise to an unwanted
- 25 waste of powder.

The stirring element is arranged over the cavity with a distance up to a few millimeters. This distance may vary due to different characteristics of different powders but tests have shown that the optimum distance is about 1

30 mm. In order to further increase the compaction of the powder in the cavity

a reciprocating movement could be applied to the stirring element 9, 9'. This reciprocating movement could be provided by a pneumatic cylinder arranged on or in contact with the shaft 7. The suitable length of each stroke is between 0.5 to 10 mm.

5

In fig. 5 an apparatus according to the invention is shown mounted in a so called blister machine for production of an elongate carrier such as a tape, web or belt provided with the cavities 30 which are to be filled with finely divided powdered medicament. Such a blister machine is well known in the state of the art and is normally provided with several stations in which the different production steps are performed. In this manner several different steps are performed mutually to different parts of the elongate member. After the completion of one step the elongate member is transported one step forward and the steps are repeated. The application of this type of machine for the production of an elongate member having cavities filled with an exact quantity of finely divided powder according to the present invention is now described in more detail.

The cavities on the elongate carrier are preferably produced in a first step whereby a first elongate member 32 is provided on a first roller 34. The elongate member 32 is fed to a forming station 40 where the cavities 30 are formed in any suitable known manner, such as thermo or cold forming or stamping. The elongate member 32 with the cavities 30 is fed to the filling device A for filling the finely divided powder into the cavities. When a cavity is positioned under the filling head 14 the oscillating movement of the filling head 14 and the rotational movement of the stirring element 9, 9' are initiated and the powder compartment 15 with the powder describes an oscillating movement. The stirring element 9, 9' rotates around its central axis in a fixed position in relation to the powder compartment and the cavity, whereby it rotates centrally over the cavity 30. Due to the rotational

forces the finely divided powder particles are transported from the powder compartment to and compacted in the cavity.

5 After the filling of the cavities of the first elongate member 32 it is fed to a position where a second elongate member 36 fed from a second roller 38 is positioned on top of the first elongate member 32. The first and second elongate members 32 and 36 are thereafter fed to a welding or sealing station 42 where the second elongate member 36 is welded or sealed on to the upper side of the first elongate member 32. The welding or sealing may involve  
10 any known method, such as heat sealing, ultra sonic welding or any other suitable method.

The two elongate members are thereafter cut in cutting station 44 to the required size and packed to be placed in a multi-dose, breath actuated, dry  
15 powder inhalator or any other package.

When the method according to the invention is used in the production of unit dose, breath actuated, dry powder inhalators for single use produced from an elongate carrier, three further stations are added to the apparatus  
20 described in fig. 5 as can be seen in fig. 6. An example of an inhalator of this type is described in WO 92/04069 and WO 93/17728; the contents of these two applications are incorporated herein by reference.

After the filling of the cavities 30, which is done in accordance with the  
25 process described above, each cavity is provided with a protective and sealing tape 46 at the station 48 (as shown in figs. 4 and 5). The cavities can also be provided with a hole in their lower part in order to facilitate the extraction of the dose into the inhalation channel during inhalation. In this case a second protective and sealing tape has to be provided on the lower  
30 side of the cavities on the first elongate member. This is done in the station



48 at the same time as the protective and sealing tape 46 is provided over the cavities on the upper side of the elongate member.

5 As shown in fig. 4 the second elongate member 36 is formed in the forming station 50 in the required manner and is then placed on top of the first elongate member 32 with the filled cavities 30 and the two elongate members are fed to the welding station 42. After the welding or sealing the two elongate members are cut in a cutting station 44 to the unit dose inhalators.

10

The two elongate members may be produced from layers of any suitable material such as aluminium or different kinds of plastics as well as combinations thereof. Tests have shown that in the case where a unit dose inhalator is produced and filled according to the invention the material of the lower tape 32, in which the cavities are formed, is preferably made of aluminium, plastic materials or laminates of these two materials, which can be heat or cold formed, but any other suitable material may be used.

15

The protective tape is preferably made of a thin aluminium foil but could of course be made of any other suitable material having a sealing and covering function. The material should preferably be impermeable to moisture and light as many finely divided powdered medicaments are hygroscopic and sensitive to light. It is however, in the case of a unit dose inhalator, important for the easy handling of the inhalator that the tape is easy to remove from the upper side of the elongate member and cavity as well as from the lower side of the elongate member if the cavity is provided with a hole.

20

The method, device and apparatus according to the invention is suitable to be used for filling any type of finely divided powdered medicament consisting of one or more substances.

25

30

### Modifications

- 5 The method, device and apparatus as described above can of course be modified within the scope of the appended claims.

Thus the construction of the filling head may be modified in order to meet requirements arising from filling of different types of powders:

10

For example, the stirring device can be modified further. A whisk-like device can for example be used which has a similar function, namely to break down the aggregates formed in the finely divided powder and to transport the powder down into the cavities and to compact it therein.

15

In the preferred embodiment of the invention an electrically driven motor with driving wheels and a transmission belt have been used but any other suitable means could be used for providing and transmitting a movement to the main shaft.

20

- The material of the layers as well as the materials of the filling head and the stirring device can be modified. The apparatus according to the invention can also be modified to fill exact quantities of finely divided powdered medicament into cavities formed in, or on, single pieces of plastics or similar, preferably made of moulded plastic, whereby each piece constitutes a  
25 bottom plate to be used as a carrier member for the cavity to be filled with powder in the production of a unit-dose, breath-actuated, dry powder inhalator.

In the preferred embodiment the filling device is adjustable in its position in relation to the cavity both horizontally and vertically. The supporting frame 17 is horizontally adjustable in its mounting on the stand comprising the motor. The mounting element 18 is vertically adjustable in relation to the  
5 supporting frame 17.

Claims

1. Device for filling with a high accuracy a finely divided powdered medicament having a particle size smaller than 10  $\mu\text{m}$  into cavities having a size corresponding to the amount of powder to be filled, characterised in that said device comprises oscillating and rotating means for breaking down aggregates formed in the finely divided powdered medicament and for filling and compacting said powdered medicament in said cavities.
2. Device according to claim 1, characterised in that the filled amount of powdered medicament is between 10 mg and 0.1 mg, in particular between 5 mg to 0.5 mg.
3. Device according to claim 2, characterised in that the device comprises a filling head (14) provided with a powder compartment (15) and a stirring element (9, 9') arranged inside said powder compartment (15) whereby, in use, the filling head (14) is arranged to describe an oscillating movement around the stirring element (9, 9') and the stirring element (9, 9') rotates around its central axis, whereby powder is transported from the powder compartment (15) to cavities (30).
4. Device according to claim 3, characterised in that the device comprises means (22, 23, 16, 20a, 20b) providing a rotational movement to a main shaft (10) transferring said rotational movement via a linking arm (12) to a shaft (13) arranged excentrically in the filling head (14), whereby said main shaft (10) also transfers said rotational movement via gear wheels (8, 11) to a shaft (7) mounted on the stirring element (9, 9').

5. Device according to claim 3 or 4,  
characterised in that the part (9a) of said stirring element (9) which, in use, transports powder from the filling head (14) to the cavity is formed as a brush (9c).
- 5
6. Device according to claim 3 or 4,  
characterised in that that the part (9a') of said stirring element (9') which, in use, transports powder from the filling head (14) to the cavity is formed as a
- 10 substantially cylinderformed, rigid element (9c') provided with cut outs.
7. Device according to any of claims 4 and 5 or 4 and 6,  
characterised in that a reciprocating movement is provided to the stirring element (9,9').
- 15
8. Device according to claim 4,  
characterised in that said means for providing the rotational movement to the main shaft (10) comprises a motor (22), preferably an electrical motor, having a motor shaft (26), a pair of driving wheels (20a, 20b)
- 20 arranged on said motor shaft (26) and said main shaft (10) respectively; and a transmission belt (16) arranged between said driving wheels (20a, 20b).
9. Device according to claim 4,  
characterised in that said finely divided powdered medicament is
- 25 supplied to said powder compartment (15) arranged in said filling head (14) by a screw-feeder device.

10. Method of filling with high accuracy a finely divided powdered medicament having a particle size smaller than 10  $\mu\text{m}$  into cavities having a size corresponding to the amount of powder to be filled, wherein the finely divided powdered medicament is transported to and compacted in said  
5 cavities by oscillating and rotating means (14; 9, 9').

11. Method according to claim 10, wherein said oscillating and rotating means (14; 9, 9') comprise a filling head (14) having a powder compartment (15) formed as a groove and a stirring element (9, 9') arranged inside said  
10 powder compartment (15) whereby said filling head (14) with the powder compartment, in use, oscillates around said stirring element (9,9') and whereby said stirring element (9,9') rotates around its central axis and is fixed in relation to the filling head (14).

12. Method according to claim 11, wherein the rotation of the stirring element (9, 9') will, in use, transport said finely divided powdered medicament from the powder compartment (15) arranged in the filling head (14) to the cavities (30) and compact the powder in the cavities.

13. Method according to any of claims 10 to 13, wherein the amount of finely divided powdered medicament to be filled in the cavities is between 10 mg and 0.1 mg, in particular between 5 mg and 0.5 mg.

14. Method of manufacturing an elongate member with cavities containing a  
25 finely divided powdered medicament having a particle size smaller than 10  $\mu\text{m}$ , the amount of powder in each cavity being between 10 mg and 0.1 mg, in particular between 5 mg to 0.5 mg including the steps of  
a) feeding a first elongate member (32) from a first roller (34) to a forming station (40),

- b) forming cavities (30) in the elongate member (32),
- c) feeding the elongate member (32) to a filling device as described in claims 1 to 9,
- d) filling and compacting a finely divided powdered medicament into the
- 5 cavities (30) using the method described in claims 10 to 13,
- e) placing a second elongate member (36) on top of the first elongate member (32) with the filled cavities,
- f) welding or sealing the second elongate member (36) on to upper side of the first elongate member (32), and
- 10 g) cutting the elongate members in predetermined lengths.

15. Method according to claim 14, comprising a further step of providing a protection member (46) over the openings of the filled cavities.

- 15 16. Appartus for carrying out the method as described in claim 14, comprising a first roller (34) from which an elongate member (32) is fed, a forming station (40) for forming cavities (30) in the elongate member (32), a filling device as described in claims 1 to 9 for filling the finely divided powdered medicament into the cavities (30), a second roller (38) from which
- 20 a second elongate member (36) is fed, a welding or sealing station (42) for welding or sealing the second elongate member (36) on to the upper side of the first elongate member (32) and a cutting station (44) for cutting the elongate members into predetermined lengths.

- 25 17. Appartus according to claim 16, comprising a station (48) for providing a protection tape (46) over the filled cavities.

18. Use of the method as described in claims 10 to 13 for filling cavities provided on a tape with a finely divided powdered medicament having a particle size smaller than 10  $\mu\text{m}$ , wherein the cavities have a size corresponding to an amount of powder of 10 mg to 0.1 mg, in particular 5  
5 mg to 0.5 mg, by using a device as described in claims 1 to 9.

19. Use of a device as described in claims 1 to 9 for filling a unit dose, breath actuated, dry powder inhalator for single use using the method as described in claims 10 to 13.

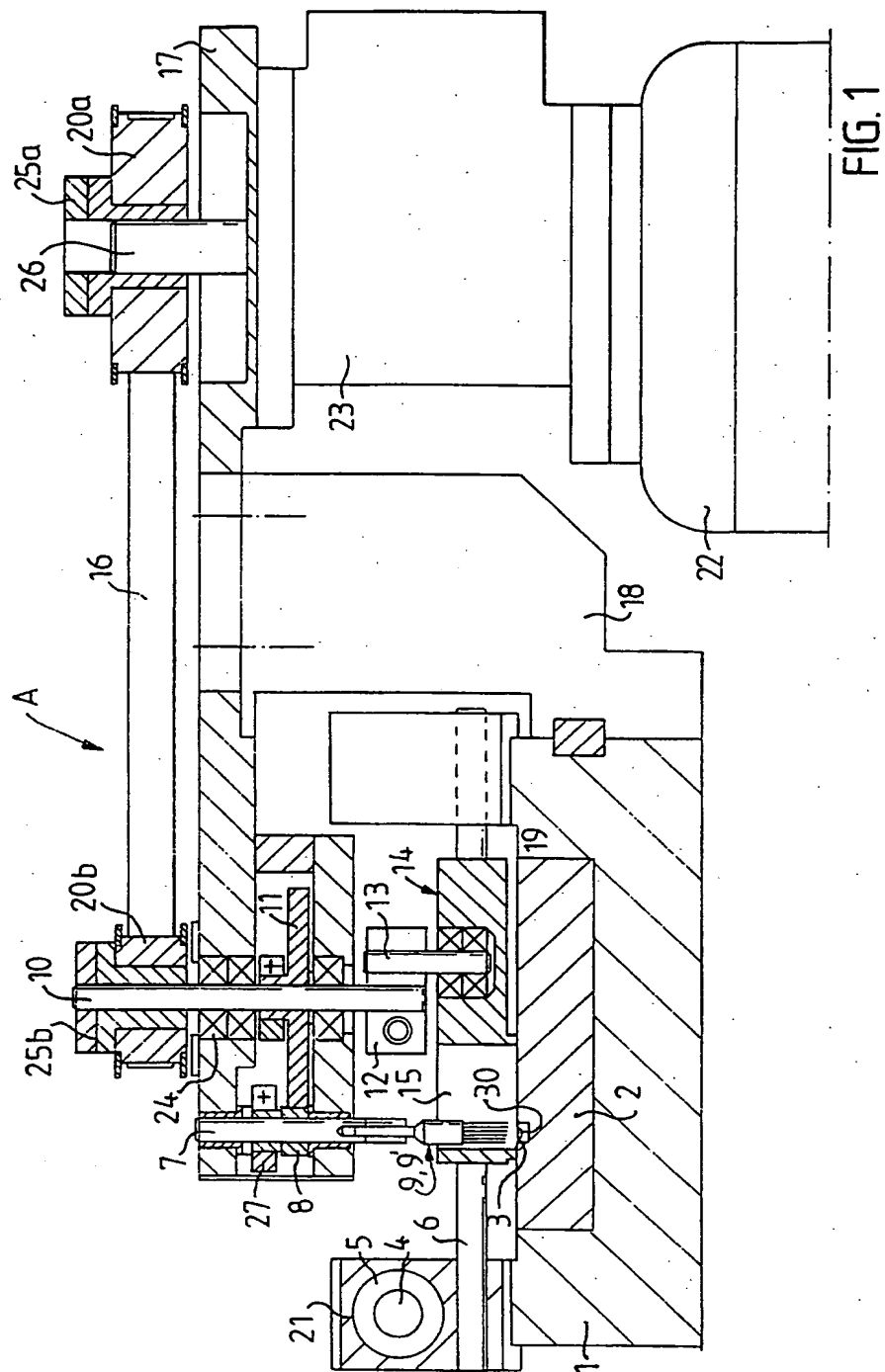
10

20. Use of a device as described in claim 1 to 9 for filling cavities provided on a tape intended to be used in a multi dose, breath actuated, dry powder inhalator for multiple use by using the method as described in claims 10 to 13.

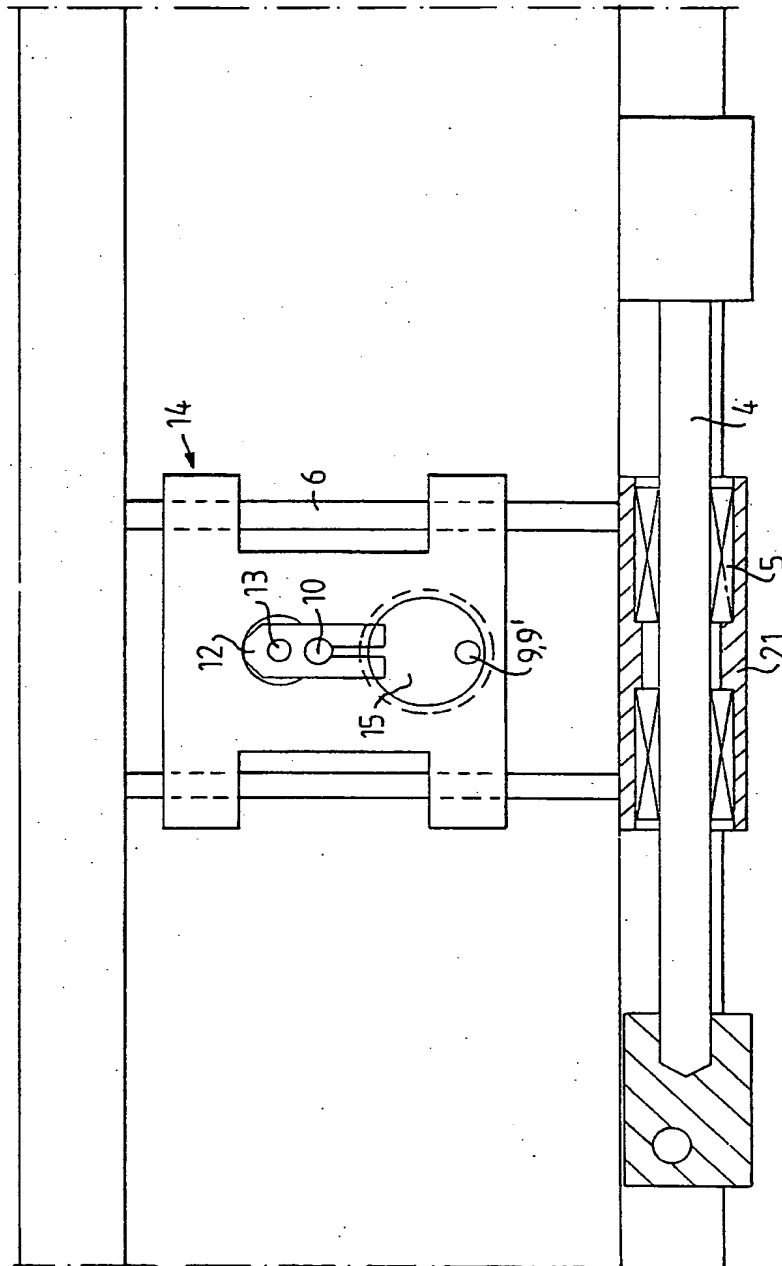
15



1/5



2/5



3 / 5

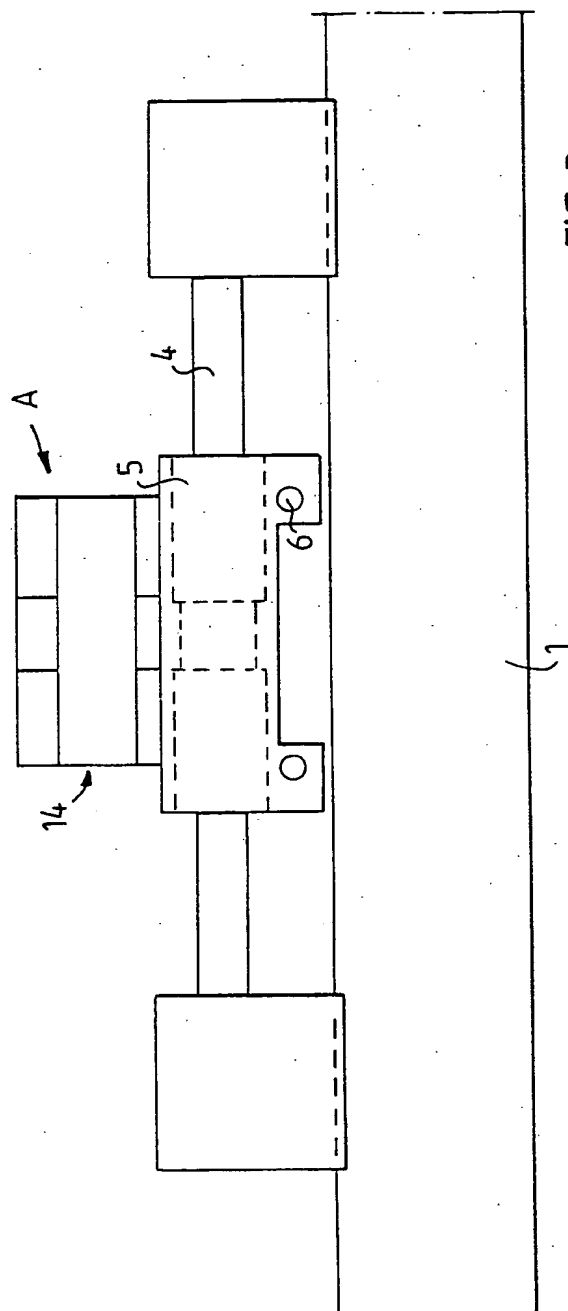


FIG. 3

4 / 5

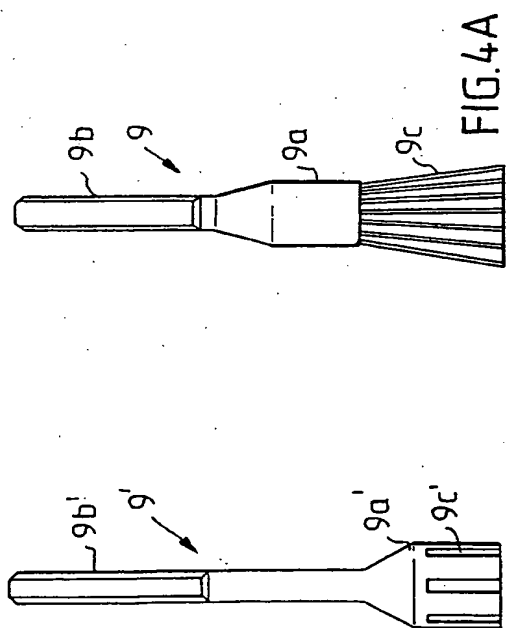


FIG. 4B

FIG. 4A

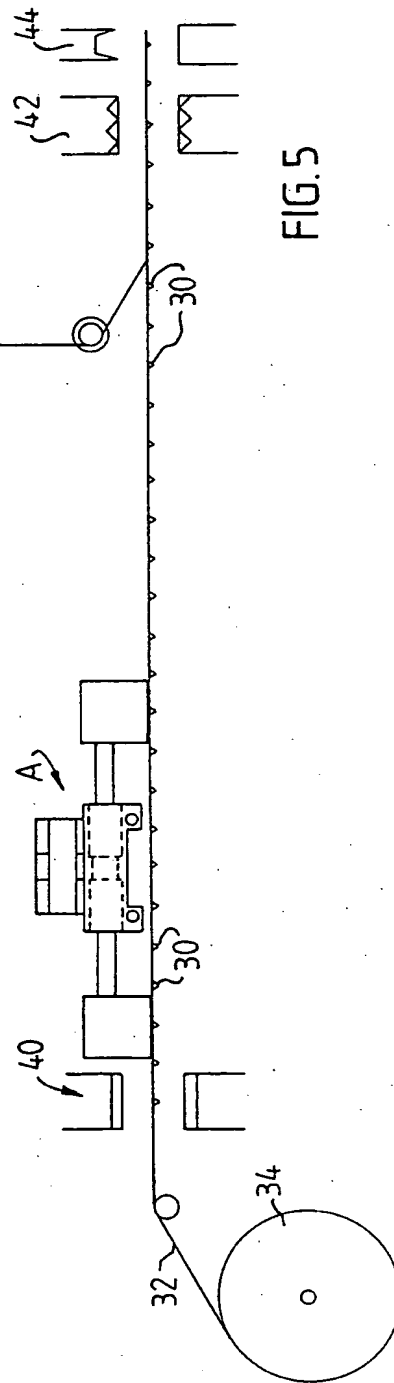


FIG. 5

5 / 5

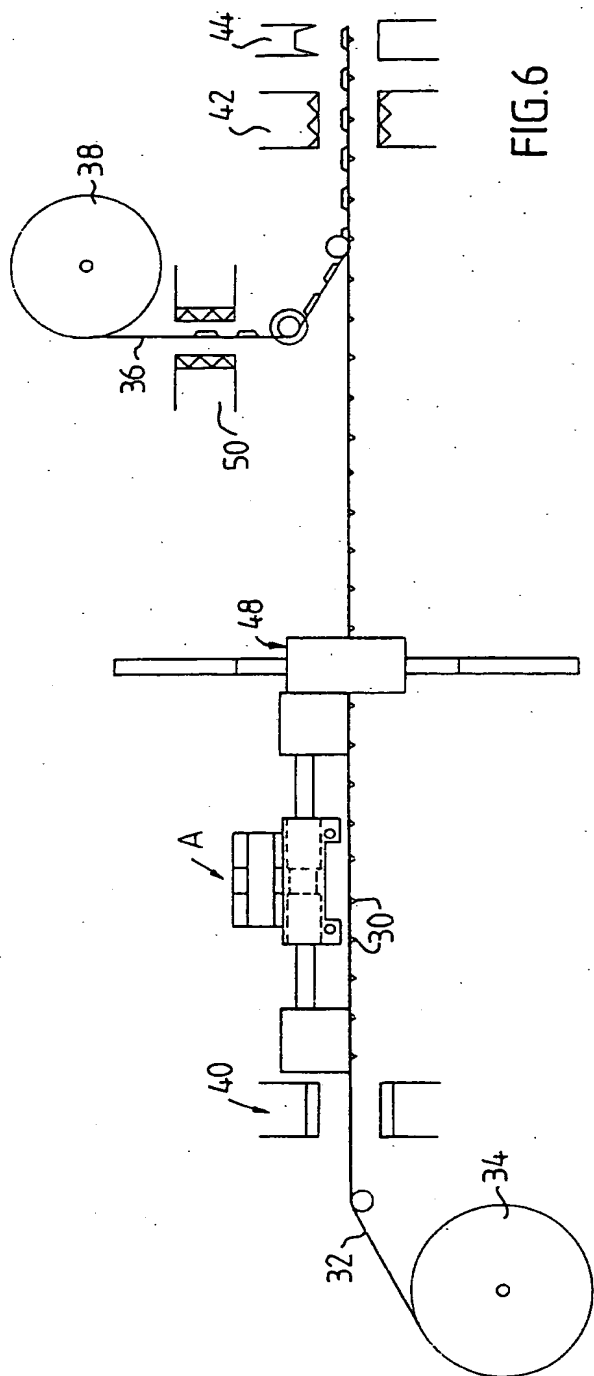


FIG. 6

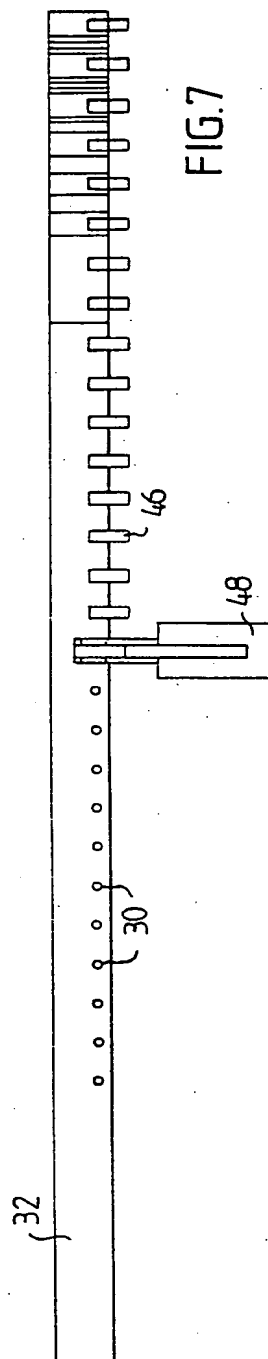


FIG. 7

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 95/00109

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B65B 9/04, G01F 13/00, A61J 3/07

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B65B, A61J, G01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| A         | CH, A5, 613041 (BAIKER AG, GLATTBRUGG),<br>31 August 1979 (31.08.79)<br>---        | 1-17                  |
| A         | WO, A1, 9217149 (HUHTAMÄKI OY), 15 October 1992<br>(15.10.92)<br>--                | 1-17                  |
| A         | EP, A1, 0191258 (SAINT-GOBAIN VITRAGE),<br>20 August 1986 (20.08.86)<br>--         | 1-17                  |
| A         | DE, A1, 3023143 (OMORI MACHINERY CO. LTD.),<br>8 January 1981 (08.01.81)<br>--     | 1-17                  |

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

## \* Special categories of cited documents:

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*E\* earlier document but published on or after the international filing date

\*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

\*O\* document referring to an oral disclosure, use, exhibition or other means

\*P\* document published prior to the international filing date but later than the priority date claimed

\*T\* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

\*X\* document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

\*&amp;\* document member of the same patent family

Date of the actual completion of the international search

30 May 1995

Date of mailing of the international search report

07 -06- 1995

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Anna-Lena Åhs

Telephone No. +46 8 782 25 00

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 95/00109

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |  |                       |
|---|--|-----------------------|
| Category*   | Citation of document, with indication, where appropriate, of the relevant passages   | Relevant to claim No. |
| A   | DE, A1, 3141069 (KLÖCKNER-WERKE AG), 5 May 1983<br>(05.05.83)<br>--  | 1-17                  |
| A   | GB, A, 2237258 (AMERICAN CYANAMID COMPANY), 1 May<br>1991 (01.05.91)<br>--   | 1-17                  |
| A   | EP, A1, 0455463 (RIKER LABORATORIES, INC.),<br>6 November 1991 (06.11.91)<br>--  | 1-17                  |
| A   | CH, A5, 591856 (P. LEINER & SONS (ENCAPSULATIONS)<br>LTD.), 30 Sept 1977 (30.09.77)<br>--  | 1-17                  |
| A   | US, A, 5143126 (BOESCH ET AL.), 1 Sept 1992<br>(01.09.92), column 2, line 27 - line 56; column 4,<br>line 55 - line 58, claims 2,5<br>-- | 1-17                  |
| A   | US, A, 4582097 (IZZI ET AL.), 15 April 1986<br>(15.04.86), column 2, line 48 - column 3, line 12<br>--<br>-----                          | 1-17                  |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

03/05/95

International application No.

PCT/SE 95/00109

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|---|---------------------|----------------------------|---------------------|
| CH-A5- 613041                             | 31/08/79            | DE-A,B,B 2701010           | 11/08/77            |
| WO-A1- 9217149                            | 15/10/92            | AU-B- 656317               | 02/02/95            |
|   |                     | CN-A- 1065200              | 14/10/92            |
|   |                     | EP-A- 0577593              | 12/01/94            |
|   |                     | JP-T- 6505885              | 07/07/94            |
| EP-A1- 0191258                            | 20/08/86            | SE-T3- 0191258             |                     |
|   |                     | CA-A- 1281948              | 26/03/91            |
|   |                     | FR-A,B- 2575825            | 11/07/86            |
|   |                     | JP-A- 61183015             | 15/08/86            |
|   |                     | US-A- 4789569              | 06/12/88            |
|   |                     | US-A- 5104230              | 14/04/92            |
| DE-A1- 3023143                            | 08/01/81            | NONE                       |                     |
| DE-A1- 3141069                            | 05/05/83            | NONE                       |                     |
| GB-A- 2237258                             | 01/05/91            | US-A- 5074102              | 24/12/91            |
| EP-A1- 0455463                            | 06/11/91            | SE-T3- 0455463             |                     |
|   |                     | AU-B- 645788               | 27/01/94            |
|   |                     | AU-A- 7391691              | 07/11/91            |
|   |                     | DE-D- 69105609             | 00/00/00            |
|   |                     | ES-T- 2064908              | 01/02/95            |
|   |                     | JP-A- 7024032              | 27/01/95            |
|   |                     | NZ-A- 237645               | 23/12/93            |
|   |                     | US-A- 5192548              | 09/03/93            |
| CH-A5- 591856                             | 30/09/77            | AU-A- 1174476              | 15/09/77            |
|   |                     | FR-A,A- 2304252            | 08/10/76            |
| US-A- 5143126                             | 01/09/92            | DE-D- 59100388             | 00/00/00            |
|   |                     | EP-A,B- 0441740            | 14/08/91            |
|   |                     | SE-T3- 0441740             |                     |
|   |                     | ES-T- 2044710              | 01/01/94            |
| US-A- 4582097                             | 15/04/86            | AU-B- 579821               | 15/12/88            |
|   |                     | AU-A- 2871584              | 18/04/85            |
|   |                     | CA-A- 1227855              | 06/10/87            |
|   |                     | DE-A- 3467878              | 14/01/88            |
|   |                     | EP-A,A,A 0125932           | 21/11/84            |
|   |                     | JP-A- 60077801             | 02/05/85            |